

***Report on the Supply and Demand of CFC-12  
in the United States***

***1999***

*Prepared for*

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Office of Air and Radiation  
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## **1999 Supply and Demand Estimates for CFC-12 (R-12) in the United States<sup>1</sup>**

### **I. Overview**

Production of CFC-12 for use in the United States ceased on December 31, 1995 in accordance with the requirements of the Copenhagen Amendments to the Montreal Protocol and the Clean Air Act. Since this production phaseout, the national supply of CFC-12 has depended upon the quantity of CFC-12 contained in stockpiles at the beginning of 1996, the quantity of CFC-12 reclaimed from existing air conditioning and refrigeration equipment, and illegal imports of CFC-12. The demand for CFC-12 is determined by the number of operating R-12 air conditioning and refrigeration systems that require refrigerant to replace R-12 lost through leakage and upon servicing (R-12 is the name for CFC-12 when it is used as a refrigerant).

This report presents updated estimates of the supply and demand of R-12 in the United States during the period 1999 to 2005. Table A-1 in Appendix A presents those individuals who reviewed the document and their comments. Comments were incorporated, as appropriate. The key conclusions of this analysis are as follows:

- **R-12 Inventory:** The total inventory of R-12 refrigerant contained in the U.S. at the beginning of 1999 is estimated to range between 24 million and 48 million pounds.<sup>2</sup> This refrigerant is held by chemical manufacturers, chemical packagers and reclaimers, original equipment manufacturers (OEMs), automotive part chains and distributors, do-it-yourselfers, stationary/commercial air conditioning and refrigeration distributors, and wholesale clubs.
- **R-12 Shortages:** It is highly unlikely that spot shortages will occur for buyers this year. Based on information from industry sources, the supply of R-12 is abundant and no true shortages will occur. It is possible that a heat wave in a densely populated area could cause a perceived shortage of R-12 because of distribution problems, however, this is highly unlikely (Dooley, 1999). The possibility of a shortage in 2000 is more difficult to predict because it is dependant on the rates at which R-12 equipment is retrofitted or replaced, as well as the amount of reclamation of R-12 over the next year. Furthermore, shortages could be sector-specific. In the stationary/commercial sector, for example, there is no immediate danger of shortages. Because of the uncertainty in the conversion and retirement rate of chillers, however, R-12 supply in that sector is less predictable. In general, at this stage, equipment is no longer being retrofitted or replaced predominantly due to a lack of R-12 supplies, but due to the aging and retirement of R-12 equipment, or in some cases due to corporate decisions to move in the direction of environmentally more acceptable alternatives (Kestenbaum, 1999).
- **R-12 Reclamation:** The efficiency of reclamation equipment has increased over the last few years, despite the fact that the availability of R-12 for purchasing, packaging and reclaiming has declined (Romine, 1999). According to an EPA database, a total of 179,419 pounds of R-12 was reclaimed in 1997, while only 111,124 pounds were reclaimed in 1998 (1999 data was not available at the time this report was drafted) (Smagin, 1999).

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<sup>1</sup> Updating the May 15, 1998 Revised Report on Supply and Demand of CFC-12 (R-12) in the United States under EPA Contract No. 68-D5-0147, Work Assignment 2-01 (Task 3).

<sup>2</sup> This estimate of the total inventory of R-12 available at the beginning of 1999 does not include R-12 contained in operating refrigeration and air conditioning equipment. As detailed in Sections III and IV of this analysis, some portion of the refrigerant that is in operating equipment is assumed to be recycled or reclaimed upon servicing, retrofitting, or retirement of the equipment over the next few years.

- **Illegal Imports:** Illegal imports have been significantly curtailed through aggressive law enforcement and industry vigilance in spotting and reporting suspicious CFC supplies. The R-12 that is seized by the government is impounded in Richmond, Virginia. There are currently approximately two million pounds in this inventory (Dooley, 1999). Also, because machinery is no longer manufactured to use R-12 and much of the R-12 equipment has been retrofitted or replaced to use R-134a, the demand for R-12 has declined in the U.S. so that there is less potential profit in smuggling.

Section II, below, presents estimates of the total inventory of R-12 available in the U.S. at the beginning of 1999 and describes the methodologies used to develop these estimates.

## **II. National Supply of R-12 Available at the Beginning of 1999**

The purpose of this section is to estimate the total national supply of R-12 available for use in the U.S. at the beginning of 1999. Section A describes the methodology used to develop the supply estimate, while Section B details the results of the analysis. Sections C through E cover potential sources of supply that are not incorporated into this analysis.

### **A. Methodology**

The total supply of R-12 available for use in the U.S. at the beginning of 1999 is comprised of the quantity of virgin and reclaimed R-12 either stockpiled or held in the distribution network. The total supply of refrigerant available for use in the future is the sum of the stockpile available now plus any R-12 reclaimed from air conditioning and refrigeration equipment in the future plus illegal imports of R-12 into the U.S. This section describes the methodology used to estimate the total supply of R-12 available in the U.S. at the beginning of 1999.

The following industries or sectors are involved in the chain of commerce of R-12 that could potentially hold virgin or reclaimed refrigerant:

- R-12 chemical manufacturers
- Original equipment manufacturers (OEMs) of mobile air conditioners (MACs)
- Packagers and reclaimers
- Automotive part chains and distributors
- Do-it-yourselfers
- Stationary air conditioning and refrigeration distributors
- Wholesale clubs

As has been done in each of the last three years, representatives of companies and trade associations were contacted for each sector (with the exception of do-it-yourselfers) to obtain their best estimates of both their company's or association members' total R-12 holdings and the total quantity held by that industry sector. Collection of information regarding R-12 supply was complicated by confidentiality concerns, a lack of solid marketing information and differing opinions of contacts on the quantity of R-12 available. Since R-12 is no longer in production, the producers and distributors that once tracked the market with great interest and resources now have little business incentive to do so. As a result of the difficulty of obtaining estimates of stocks, ranges were established to account for the variances among individual source estimates. In addition, a literature search was conducted of trade publications that could contain national supply estimates. Finally, estimates of the quantity of R-12 held by do-it-yourselfers were derived by simply assuming a certain amount of use by this sector and subtracting this amount from the 1998 estimate of their holdings.

### **B. Estimates of Total Supply of R-12 Available at the Beginning of 1999**

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Exhibit 1 presents the estimated supply of R-12 in the U.S. at the beginning of 1999 for each of the industry sectors involved in the chain of commerce for R-12. As indicated in this exhibit, the national supply of R-12 is estimated to range from 24 million to 48 million pounds. Exhibit 1 also divides the national supply estimate into two components: the quantity of R-12 in the distribution pipeline for sale in 1999 and the quantity stockpiled for future use. The pipeline estimate represents the supply of R-12 held at various stages of the distribution system for sale in 1999. The stockpile estimate represents R-12 that was added to the normal pipeline in anticipation of the impacts of the production phaseout and is intended by its owners to last beyond 1999.

**Exhibit 1:  
CFC-12 Inventory in the U.S. at the Beginning of 1999 (million pounds)**

Industry Sector	Projected/Estimated Supply to be Sold in 1999	Projected/Estimated Stockpile for Future Years	Total Inventory Estimate
Original Equipment Manufacturers (OEMs)	6 - 7	4 - 5	10 - 12
Chemical Manufacturers	0	0	0 <sup>a</sup>
Packagers/Reclaimers	2 - 5	3 - 10	5 - 15
Automotive Parts Chains and Distributors	1 - 4	2 - 5	3 - 8
Stationary/Commercial Sector Distributors	2 - 5	3 - 7	5 - 11
Wholesale Clubs	1 - 2	0	1 - 2
Do-It-Yourselfers	0	0	0 <sup>a</sup>
<b>TOTAL</b>	<b>12 - 23</b>	<b>12 - 27</b>	<b>24 - 48</b>

Note: These estimates do not include R-12 being held for use in metered dose inhalers, by the Department of Defense for critical uses, or estimated illegal imports.

<sup>a</sup> However, it could be assumed that some chemical manufacturers and do-it-yourselfers still carry small amounts of R-12, but these quantities are negligible with respect to the order of magnitude of this analysis.

The quantities of R-12 held by each entity in the chain of commerce can be summarized as follows:

- **Automotive Original Equipment Manufacturers (OEMs):** Estimates of the total quantity of R-12 held by original equipment manufacturers (OEMs) such as Ford, GM, and Chrysler range from 10 million to 12 million pounds (Mulnar, 1999). About 55 million vehicles still use CFCs in 1999 and this number is expected to drop to only 13 million in 2004 (Rees, 1999). Automobiles that use R-12 are being converted or replaced fairly quickly. In fact, in many cases, it is less expensive to convert to R-134a equipment than it is to continue using R-12 (Rees, 1999; Allison, 1999). Despite this, automakers still have a significant business interest in maintaining their inventories of R-12 so that they can continue to service their products, (particularly those vehicles with R-12 air conditioners that remain under warranty).
- **Chemical Manufacturers:** Chemical Manufacturing companies, which include Allied Signal, DuPont, LaRoche, Elf Atochem, and ICI, no longer produce R-12; however some are now selling virgin and reclaimed R-12 (Hinchman, 1999). In general, the chemical manufacturers' supplies

are negligible, and they primarily only hold supplies of R-12 for specific customers who have already contracted to purchase the refrigerant. Some chemical manufacturers have even sold their entire stock of R-12 and now produce alternatives to R-12 (so they have an economic incentive to encourage transitions and retrofits rather than to foster the continuing use of R-12).

- **Packagers/Reclaimers:** Refrigerant reclaimers and packagers (combined) have estimated inventories of 5 million to 15 million pounds of R-12. In addition to contributing to the current inventory of R-12, reclamation provides the only legal future source of R-12 other than that which has been stockpiled or will be recycled by equipment owners. The primary limits on output of reclaimed R-12 are the availability of used R-12 from existing or retired equipment and the ability of reclaimers to process the R-12 that they receive. In recent years, the efficiency of reclamation equipment has improved, therefore increasing the potential to reclaim refrigerant (Romine, 1999). As a result, reclamation was expected to increase as more R-12 equipment is retired, but so far no dramatic increase has occurred in 1999. In fact, reclamation appears to have been decreasing over the last few years from a high of near 3 million pounds to closer to 2½ million pounds (Kestenbaum, 1999). Furthermore, R-12 recovered from automotive air conditioners is usually recycled on-site and reused in other automotive air conditioners, and hence, it is not sent to reclaimers, but does reduce demand for R-12.
- **Automotive Parts Chains and Distributors:** Automotive part chains and distributors hold an estimated 3 million to 8 million pounds of R-12 in their inventories. This season there will be no shortages in this industry sector. In fact, one industry representative believes there could even be a slight oversupply (Lowe, 1999).
- **Stationary/Commercial Sector Distributors:** The stationary air conditioning and commercial refrigeration sectors are also significant consumers of R-12. Inventories set aside for stationary and commercial uses are estimated to be from 5 million to 11 million pounds. However, because conversion and replacement of chillers is occurring at a slower rate than originally anticipated, (and complete replacement could take at least a decade), it is possible that the demand within this end-use could increase as supplies of virgin CFCs start to dwindle (Environmental Information Networks, Inc., 1998b and Dooley, 1999).
- **Wholesale Clubs:** Wholesale clubs such as Sams, Costco, and BJ's no longer have very significant stocks of R-12. In fact, these establishments have an estimated 1 million to 2 million pounds of R-12. For example, Sams Club has a supply for 1999, but does not expect to purchase a supply for 2000, primarily because they have been losing money on their R-12 sales (Smith, 1999). Mass merchandisers, such as WalMart and K-mart, have not been significant outlets for R-12 refrigerant sales since prior to the phaseout.
- **Do-It-Yourselfers:** Estimates of the amount of R-12 held by "do-it-yourselfers" in the general public are close to zero. R-12 held in this sector is very difficult to estimate because it involves very small quantities of chemical held by thousands of people. In addition to the uncertainty of the amount of R-12 held by do-it-yourselfers, the availability of chemical held by this sector is probably quite limited. R-12 held by the general public is most likely intended for use in servicing of MACs, particularly those owned or serviced by the people holding the chemical. This helps the overall market because, by using their own inventory, do-it-yourselfers do not need to tap into the stockpiles in place at various levels throughout the chain of commerce. However, if do-it-yourselfers do not exhaust all of their supply of R-12, they are unlikely to transfer any remaining chemical to distributors for use elsewhere.

C. Illegal R-12 Imports

All imports of newly produced R-12 are banned except for those for which R-12 users hold essential use exemptions. Imports of previously used material are permitted, but requests for such imports must be submitted to EPA and are subject to stringent approval criteria.

Although estimates of illegal activity are difficult to derive, most industry representatives contacted believe that large shipments of illegally imported R-12 have been eliminated through a combination of U.S. law enforcement efforts and industry attention to improperly labeled chemical.<sup>3</sup> By mid-1997, for example, 2 million pounds had been impounded. By the end of February 1999, more than 90 individuals and businesses had been charged for smuggling of ozone-depleting substances into the U.S. The volume of illegal trade has fallen since 1995 and is estimated to be 5 - 10 million pounds each year for 1996 and 1997. By comparison, according to EPA and U.S. Customs, approximately 15 - 30 million pounds of R-12 were illegally imported into the U.S. over 1994 and 1995, or approximately 7.5 - 15 million pounds in each of those years.<sup>4</sup>

However, criminals may continue smuggling CFCs because it is lucrative and will continue to be so as existing supplies shrink. Illegal importers of R-12 do not pay the excise tax, which is \$7.15 per pound in 1999 (Land, 1999) (and will go up \$0.45 per year in all subsequent years), so they are able to undersell legitimate R-12 distributors and still make significant profits. Much of the smuggling today is in smaller quantities on a broader front, entering across the Mexican border and into ports on both coasts. Mexico is a particularly convenient source of R-12 because as an Article 5 country under the Montreal Protocol, Mexico does not have to end CFC production until January 1, 2010 and therefore R-12 can be produced legitimately until that time. Smugglers entering from Mexico often carry very small amounts of R-12 that can be carried or concealed in luggage. For example, the Houston U.S. Customs Office reported 619 seizures (totaling 42,942 pounds of R-12) in Texas between April 1998 and March 1999. Six hundred and seventeen of these seizures involved material illegally imported from Mexico; the other two seizures involved material from Venezuela. China, Russia and India have also been suspected as significant sources of illegal R-12 smuggled into the U.S. The Environmental Investigation Agency (EIA), an independent environmental campaigning organization with offices in London and Washington D.C., has investigated illegal trade of CFCs around the globe. The group believes that in the first half of 1998 more than 400 thousand pounds of Chinese CFCs were allowed into the U.S. (Asia Environmental Review, 1999). Furthermore, future shortages may increase the probability of a sustained R-12 black market.

Because of the uncertainties regarding the amount of illegally imported R-12 and the government's vigorous efforts to discourage people from purchasing illegally imported chemicals, illegal imports are not included in the projections contained in Exhibit 1 and are not included as a future supply source in this analysis.

D. Essential Use Exemptions

In recognition that non-ozone-depleting alternatives would not be available by the January 1, 1996 phaseout date for a small number of important products, the Parties to the Montreal Protocol established a process for exempting certain "essential uses" from the Protocol's production and import bans. Among the essential uses granted to date is the use of CFC-12 as a propellant in metered dose inhalers (MDIs), which are used in the treatment of asthma and chronic obstructive pulmonary disease.

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<sup>3</sup>Unusually low prices and/or large supplies of refrigerant may be clues that illegal importation is occurring. The main method for smuggling CFCs into the U.S. in 1994 and 1995 was fraudulent documentation.

<sup>4</sup>Although it was not illegal to produce R-12 in 1994 and 1995, the price of R-12 rose during those years due to increases in the federal excise tax on CFCs. This tax, which had originally been introduced in 1990, may have created an incentive for illegal trade (i.e., to evade the federal excise tax).

The CFCs used in MDIs must meet strict pharmaceutical standards set by the U.S. Food and Drug Administration, so that they are distinct from material used in the air conditioning and refrigeration market. Every year since the phase-out date, pharmaceutical companies have obtained essential-use allowances from the Parties to the Protocol. In 1999, the essential-use allowances total 2434.4 metric tonnes. The pharmaceutical industry is currently storing some CFC-12 for use in MDIs, while the excess chemical unable to be stored by pharmaceutical companies is being held for them by chemical manufacturers.

Because the CFCs used in MDIs are distinct from material used in the air conditioning and refrigeration market, and because the demand for CFC-12 for use in MDIs should be met from current stockpiles or from future production authorized by essential use allowances, CFCs used in MDIs are not incorporated into this analysis. Consequently, stockpiles of CFC-12 for MDIs have not been included in the CFC-12 inventories presented in Exhibit 1.

#### **E. Department of Defense Stockpile**

The U.S. military has divided its CFC-12 uses into two categories: critical and non-critical. Critical uses include CFC-12 in weapons platforms for which an alternative is not available that meets the specifications of the weapons systems. To ensure supplies for critical military uses, the Department of Defense established a reserve of CFC-12 and other ozone-depleting substances which is being held by the Defense Logistics Agency (DLA). DLA manages reserves for the military and most other federal government agencies. The amount of R-12 held by the DLA is confidential and is also constantly changing as reclaimed chemical is brought into the supply and R-12 is dispersed for military use. To date, the use of CFC-12 in the military has been consistent with the projected utilization, and there are no intentions to solicit additional CFC-12 or alter the schedule of retrofits. The DLA R-12 stockpile is estimated at between 1 million and 2 million pounds.

The Navy is currently conducting an ongoing program to retrofit shipboard CFC-12 cooling systems. Completion of retrofits is scheduled for the year 2001. The Navy currently holds a stockpile of approximately 900,000 pounds of CFC-12 for use in these shipboard systems (until the completion of the retrofit program). Over half of shipboard machinery has been retrofitted or replaced to use R-134a. The Navy's shore facilities are scheduled to be completely retrofitted or replaced by December 31, 2000 (except for a few minor uses that have applied for waivers from this Navy policy in an effort to allow usage for an additional 2-5 years). It is believed that the Army and Air Force also hold a few hundred thousand pounds of R-12 (Mullenhard, 1999).

In addition to CFC-12 that has been stockpiled or reclaimed, all CFC-12 seized prior to the December 31, 1995 phaseout date has become legal property of the DLA reserve. The ownership status of CFC-12 seized since the phaseout date remains unclear, but most of it is stored by U.S. Customs. This analysis assumes that the quantity of refrigerant being held by DLA and Customs will remain outside the CFC-12 market and as a result is not included in Exhibit 1. The U.S. does not use seized R-12 internally, but manages it carefully to avoid unnecessary emissions (Sibley, 1999). Ultimately the cost of destruction technologies may decline to the point that it will be possible to eliminate the stored illegal material without incurring any additional damage to the ozone layer.

### **III. National Demand for R-12**

The purpose of this section is to estimate the total national demand for R-12 in the U.S. during the period 1999 to 2005. Section A describes the methodology used to develop the demand estimates and Section B details the results of the analysis.

#### **A. Methodology to Estimate Demand**

R-12 demand in the United States from 1999-2005 was estimated using information from EPA's Vintaging Model. This model has been used extensively by EPA to estimate the use and emissions of CFCs, halons, methyl chloroform, HCFCs, HFCs, and PFCs in the United States. Specifically, the Vintaging Model was designed to simulate the aggregate impacts of the ozone depleting substance (ODS) phaseout on the use and emissions of various fluorocarbons over a period of years. The model simulates the changes brought about by the phaseout across more than 40 different applications. In order to provide a demand schedule that would be practical for projecting the market for R-12 over the next few years, a simplified vintaging approach was developed. By presenting all the input data and assumptions, this demand calculation can be adjusted to reflect different assumptions or new information.

Key inputs to the model include:

- **Characterization of ODS-Consuming Equipment.** Each end-use in the model is characterized in terms of the total stock of equipment operating each year and by factors that contribute to the use and/or emissions of ODSs over time. Key input data to the model include:
  - Stock of equipment (based on annual additions to the stock, equipment lifetime, retrofits, and substitution of different refrigerant in new equipment);
  - Average charge size; and,
  - Average annual refrigerant loss per unit (equipment leak rate and loss during service).

The data used in the model have supported a number of previous EPA analyses. Data have been updated to reflect information contained in the 1994 UNEP Refrigeration, Air Conditioning, and Heat Pumps Technical Options Committee report, various Alternative Fluorocarbons Environmental Acceptability Study (AFEAS) reports, production estimates provided by ODS producers and contained in the Stratospheric Protection Division's ODS tracking system, conversations with industry sources, and estimates of ODS use provided to EPA by various end-users.

- **Recycling at Service.** Recycling ODSs while servicing equipment in the refrigeration and air-conditioning sectors can significantly reduce the amount of virgin chemical required from inventories. Loss rates in the model account for assumptions about the market penetration and emission reductions associated with recycling in each end-use.
- **Substitution Scenarios.** The substitution scenarios define the use of HCFCs, HFCs, PFCs, and other alternatives as replacements for CFCs as the ODS phaseout is implemented. Substitution scenarios were developed based on input from EPA sector leads within the Stratospheric Protection Division. These individuals have regular contact with industry given their responsibilities for implementing EPA's Significant New Alternatives Policy (SNAP) program. Substitution assumptions impact the estimates of the stock of equipment.

Exhibit 2 presents estimates of the national demand for R-12 in the U.S. for the years 1999 to 2005 and the information used to develop those estimates for each end-use:

- Average charge of refrigerant in the equipment;
- Average annual refrigerant loss per unit (as a percent of the total charge);
- Estimated number of CFC-12 units in operation for each end-use; and
- Estimated demand for CFC-12, by end-use.

Specifically, demand estimates for each end-use are the mathematical product of the average charge of refrigerant in the equipment, the average annual refrigerant loss per unit, and the estimated number of CFC-12 units in operation for that end-use.

**B. Estimates of National Demand for R-12 for 1999 to 2005**

As shown in Exhibit 2, the national demand for R-12 in 1999 is estimated to be approximately 23 million pounds. The mobile air-conditioning end-use accounts for 82 percent of annual demand. The second largest demand is from chillers (4 percent) and commercial refrigeration in cold storage warehouses (4 percent), followed by commercial refrigeration in supermarkets (3 percent), industrial process refrigeration (3 percent), refrigerated transport (2 percent), and refrigerated appliances (1 percent). Demand is predicted to decline as market penetration of R-12 substitutes increases and existing equipment stocks are retired.

The demand estimates presented in Exhibit 2 are generally in agreement with demand estimates calculated by The Valvoline Company, a major R-12 packager and distributor. For 1999, Valvoline estimates that R-12 demand is 22 million pounds, compared to the 23 million pounds presented in Exhibit 2. Likewise, in 2000, Valvoline's R-12 demand estimate of 18 million pounds is in close agreement with the 19 million pounds presented here. Valvoline also indicated that their R-12 stock has been depleted at a much quicker rate than last year (Wesley, 1999). Demand for R-12 coincides with its price and the rate of retrofitting and replacement of R-12 equipment. It has been suggested that as long as the price of R-12 makes it more worthwhile to refrigerant users to use R-12 rather than retrofit, demand for R-12 will remain steady, which will lead to a shortage sooner than if retrofitting was occurring at the rates originally predicted.

**IV. Domestic R-12 Supply and Demand From 1999-2005**

This section presents estimates of the supply and demand for R-12 in the U.S. for the period 1999 to 2005. Future supply and demand is determined by the quantity of R-12 available at the beginning of 1999 as estimated in Section II and predicted demand as estimated in Section III.

**A. Results**

Exhibit 3 shows the balance of R-12 in the United States from 1999 to 2003 based on the inventory estimates from Exhibit 1 and the demand estimates from Exhibit 2. Given the range for the inventory estimate presented in Exhibit 1, Exhibit 3 presents balances for low, midpoint, and high inventory estimates over time. Estimates are not provided in Exhibit 3 for the years 2004 and beyond because the low, midpoint, and high inventory estimates all show that the R-12 inventory will be depleted by 2003.

The results of this analysis can be summarized as follows:

- **Spot Shortages in 1999 Unlikely.** This analysis determined that substantial amounts of R-12 remain available in the U.S. and spot shortages are highly unlikely for buyers this year. A heat wave in a densely populated area could cause a perceived shortage of R-12 because of distribution problems, however at present R-12 is easily obtained. It is possible that the U.S. will experience an R-12 shortage in 2000, depending on factors such as the rate of retrofitting and replacement of R-12 equipment and the quantity of R-12 reclaimed.
- **Reclamation Has Decreased Slightly.** The quantity of R-12 reclaimed in 1998 decreased slightly from the amount reclaimed in 1997. Most recovered R-12 is held by

the owners to service other equipment (e.g., supermarket chains retrofit some stores and keep the recovered R-12 for their stores that still rely on R-12), rather than sent to reclaimers.

- **Potentially Strong Market for Reclamation.** Given the much slower than expected rate of retirement and conversion for R-12 chillers, for example, demand for reclaimed R-12 in this industry sector could increase noticeably from 1999-2005 as owners are faced with the prospect of a shortage. Without the availability of reclaimed R-12, shortages may occur earlier and affect more users. Nonetheless, despite the slower than expected retirement and retrofit rate for chillers, the market for reclaimed R-12 did not increase in 1998.
- **No Rise in Illegal Imports.** Even before the cessation of R-12 production in the United States, illegal imports entered the country in significant quantities because the high price of R-12 and the excise tax on R-12 made such activity very lucrative. While illegal imports will continue to enter the U.S., the amount of smuggling is not expected to increase in the future. This may be attributed to the increased success of U.S. law enforcement agencies in cracking down on illegal imports of R-12 in recent years. In fact, more and more individuals and companies are being charged for illegally importing R-12 into the U.S. now, than in previous years.

B. Limitations of the Analysis

It is important to note several additional caveats to the supply and demand estimates presented in Exhibits 1 and 2. First, as noted previously, this analysis did not account for R-12 illegally imported into the U.S. for the period 1999 to 2005. To the extent that such illegal imports occur, the R-12 supply for 1999 onwards may be larger than projected in this analysis. Second, the analysis assumes that non-critical military demand is accounted for in the civilian stream by the Vintaging Model, because these needs continue to be met, as in the past, in the civilian market (i.e., through wholesale distributors). In other words, the non-critical military equipment requiring CFC-12 is accounted for in the stock estimates presented in Exhibit 2. Critical military demand will be met through the stockpile maintained for the Department of Defense by the Defense Logistics Agency. Finally, this analysis did not consider the effects of contaminants and contractor reclamation on R-12 supply and demand, variables that could significantly affect R-12 supply and demand estimates in the future.

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**Exhibit 2**

**Estimated CFC-12 Demand in the U.S.**

	Average Charge per Unit (pounds)	Average Annual Loss per Unit (Percent of Charge)	Estimated Number of CFC-12 Units in Operation						
			1999	2000	2001	2002	2003	2004	2005
Mobile Air Conditioners (MACs) source: (EPA 1998)	2.9	12%	55,000,000	44,000,000	35,000,000	27,000,000	20,000,000	13,000,000	7,000,000
Chillers source: EPA & ARI estimates	1,400	8%	7,500	6,000	4,500	3,000	1,500	0	0
Commercial Refrigeration (Supermarkets) source: EPA estimates	1,500	25%	6,600	6,000	5,100	4,200	3,200	2,200	1,200
Commercial Refrigeration (Cold Storage Warehouses) source: EPA estimates*	0.0022	15%	2,692	2,353	2,015	1,677	1,338	1,000	662
Refrigerated Transport source: EPA estimates	16.6	18%	185,000	148,000	120,000	92,000	63,000	32,000	2,000
Industrial Process Refrigeration source: EPA estimates	2,200	5%	6,200	5,500	4,800	4,100	3,500	3,000	2,500
Refrigerated Appliances source: EPA estimates	0.38	0.9%	102,000,000	94,000,000	87,000,000	80,000,000	72,000,000	66,000,000	60,000,000

\* NOTE: For cold storage warehouses, the average charge per unit is reported in pounds per cubic feet and the estimated number of units in operation is reported in millions of cubic feet of refrigerated space.

	Estimated Demand for CFC-12 (million pounds)						
	1999	2000	2001	2002	2003	2004	2005
Mobile Air Conditioners (MACs)	18.9	15.1	12.0	9.3	6.9	4.5	2.4
Chillers	0.84	0.67	0.50	0.34	0.17	0.00	0.00
Commercial Refrigeration (Supermarkets)	2.5	2.3	1.9	1.6	1.2	0.8	0.5
Adjusted Commercial refrigeration (Supermarkets)**	0.8	0.7	0.6	0.5	0.4	0.3	0.1
Commercial Refrigeration (Cold Storage Warehouses)	0.9	0.8	0.7	0.6	0.4	0.3	0.2
Refrigerated Transport	0.55	0.44	0.36	0.27	0.19	0.10	0.01
Industrial Process Refrigeration	0.68	0.61	0.53	0.45	0.39	0.33	0.28
Refrigerated Appliances	0.34	0.32	0.29	0.27	0.24	0.22	0.20
<b>Total Demand</b>	<b>23</b>	<b>19</b>	<b>15</b>	<b>12</b>	<b>9</b>	<b>6</b>	<b>3</b>

\*\* NOTE: Two-thirds of the demand for R-12 in supermarkets is assumed to be handled internally through refrigerant management plans. Therefore, because most national and regional supermarket chains have refrigerant management plans (RMPs), they do not demand any R-12 from the open market. On the other hand, smaller grocery stores (which do not have the capital or resources needed to operate an RMP) are the only portion of this end-use that may need to purchase R-12 from the open market. Therefore, this analysis assumes that one-third of the units in operation are located in smaller grocery and convenience stores.

### **Exhibit 3**

#### **CFC-12 Balance for Low Inventory Estimates (million pounds)**

	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
Beginning Inventory	24	1	0	0	0
Reclaimed*	0.05	0.025	0	0	0
Demand/Use	23	19	15	12	9
<b>Ending Inventory</b>	<b>1</b>	<b>(18)</b>	<b>(15)</b>	<b>(12)</b>	<b>(9)</b>

#### **CFC-12 Balance for Midpoint Inventory Estimates (million pounds)**

	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
Beginning Inventory	36	13	0	0	0
Reclaimed*	0.05	0.025	0	0	0
Demand/Use	23	19	15	12	9
<b>Ending Inventory</b>	<b>13</b>	<b>(6)</b>	<b>(15)</b>	<b>(12)</b>	<b>(9)</b>

#### **CFC-12 Balance for High Inventory Estimates (million pounds)**

	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
Beginning Inventory	48	25	6	0	0
Reclaimed*	0.05	0.025	0	0	0
Demand/Use	23	19	15	12	9
<b>Ending Inventory</b>	<b>25</b>	<b>6</b>	<b>(9)</b>	<b>(12)</b>	<b>(9)</b>

\* NOTE: The amount of R-12 reclaimed is estimated based on EPA records of reclaimed R-12 for 1997 and 1998.

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